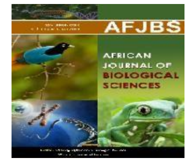
https://doi.org/10.33472/AFJBS.6.2.2024.315-329

African Journal of Biological Sciences



Research Paper Open Access

An Overview about Online Education of Goat's Eye anatomy During Pandemic of COVID-19

Eman A. A. Mahdy, Basset Aly, A. E., Esraa B. Gad, Mervat M. H. Konsowa
Department of Anatomy and Embryology, Faculty of Veterinary Medicine, Zagazig University, Egypt

esraabarakat211@gmail.com

Article History

Volume 6, Issue 2, April 2024

Received:19 April 2024

Accepted: 29 April 2024

Published: 16 May 2024

doi: 10.33472/AFJBS.6.2.2024.315-329

Abstract: After the COVID-19 pandemic emerged by ten months, online teaching appeared to be the only sustainable opportunity in medical teaching and especially in anatomy learning. Online classrooms could be an excellent way to give any theoretical lecture, but learning anatomy by this way was difficult since it needed students to engage with the online resources and use three-dimensional (3D) perception. we like to shed light on the anatomy of the eye and its various component in domestic animals with different techniques. Regarding to orbit in goat, orbital width/height was the perpendicular space between the supraorbital and infraorbital borders of the orbit. Orbital length, was the horizontal space between the rostral and caudal borders of the orbital rim. Orbital index was the orbital width / orbital length. Orbital depth was the distance between center of the orbital rim and optic foramen. The eye lids of goat were musclofibrous folds. The latter were much thinner than ox. Greater thickness was present on the upper than the lower eyelids. The lateral and medial angles (commissures) connected the eyelids on either side. There was pigmentation where the conjunctiva and lids met and the lateral angle of the lids but the medial angle of the lids lack of pigmentation. The palperal fissure was oval in shape but broader toward the medial angle. The eyelids included Meibomian (tarsal glands) and ciliary glands. Goat's meibomian glands were found in the tarsal plate of both the upper and lower eyelids; the tarsal glands in the upper eyelid were more numerous and more developed than those in the lower lid. The third eye lid consisted of the conjunctival covering of the cartilage and the glandular tissue, that was surrounding the base of the third eyelid. The cartilage within the membrane was T-shaped. The wider portion of the "T" being near the free margin of the third eyelid. The conjunctiva on the palpebral side of the cartilage reflected onto the caruncle at the medial angle of the eye. The fornix formed by the conjunctiva on the palpebral surface of the lid was not extensive. The conjunctiva lined the third eyelid eventually joined the palpebral conjunctiva of the upper and lower lids. The goat conjunctiva may contain small lymph nodules. This review declared the anatomy of the eye and its adnexa in the different domestic animals with macroscopic and microscopic anatomy, Computed tomography (CT) and angiography to mention the various component of the eye especially bony orbit, ocular muscles and the three tunics of the eye.

Keywords: Online Education, Goat's Eye anatomy, COVID-19

Introduction: A collection of images of macroscopic and microscopic anatomy of the vertebrate eye was a resource accessible in both the stationary and collaborative websites. This resource formed from existing sectors of ocular tissues mounted on glass slides, that were imaged using a Leica DMR light microscope and converted to a web-suitable format. More than 2000 images of monkey and human eye structures were assembled using Adobe Photo-shop software to recreate the appearance of the whole eye. The collaborative website had the same information presented in the stationary site, but had added wiki pages, that permitted students to appreciate levels of organization of tissues **(1)**.

The COVID-19 pandemic had a major influence on many phases of the human life, including all stages of learning especially medical teaching. The most of medical departments around the world had moved to online learning. After the COVID-19 pandemic emerged by ten months, online teaching appeared to be the only sustainable opportunity in medical teaching and especially in anatomy learning. Online classrooms could be an excellent way to give any theoretical lecture, but learning anatomy by this way was difficult since it needed students to engage with the online resources and use three-dimensional (3D) perception (**2).**

While the Covid-19 pandemic appeared, the online and blended teaching was the main learning facilities provided by the faculty for students. Indeed, most of them believed that cadaver observation and touch were important for them. The lack of practical courses and cadaveric contact decreased the strength of anatomical teaching during the COVID-19 pandemic. Indeed, anatomy was a three-dimensional topic that needed an understanding of the relation between different structures and the most effective method for accomplishing these goals was dissection **(3)**.

Online learning is not a substitute for in-person anatomy instruction. It could be used with the traditional learning as an additional teaching instrument. But, collaborative online teaching activities, using dissection videos and 3-D software were recommended for virtual learning. Deficiency of practical lessons was one of the major disadvantages of virtual anatomy learning. Students had been incapable of visualizing the professor's oral reports and their three-dimensional illustration. Lack of dissection process and inadequate physical interaction with samples lead to rise of misunderstanding the location and relation of organs in the cadaver **(4)**.

The eye was made up of the eyeball and several adnexa including the ocular muscles that move the eyeball, the eyelids that shield it and the lacrimal apparatus that maintained the moisture in its exposed areas. Most of these were kept in the orbit, where the eyeball was heavily fattened. The eyelids arose from the bony margins of the orbit and, like curtains, were periodically drawn over the exposed part of the eye (blinking) to distribute the tears or lacrimal fluid for protection. They were kept across the eye during sleep when vision was not necessary. The eye was an elaborate organ whose main purpose was to gather and concentrate light on the photosensitive retina **(5).**

Regarding to orbit in goat, orbital width/height was the perpendicular space between the supraorbital and infraorbital borders of the orbit. Orbital length, was the horizontal space between the rostral and caudal borders of the orbital rim. Orbital index was the orbital width / orbital length. Orbital depth was the distance between center of the orbital rim and optic foramen (**6).**

Regarding to the eyelids and conjunctiva in goat, **Diesem (7)** noticed that, the eye lids of goat were musclofibrous folds. The latter were much thinner than ox. Greater thickness was present on the upper than the lower eyelids. The lateral and medial angles (commissures) connected the eyelids on either side. There was pigmentation where the conjunctiva and lids met and the lateral angle of the lids but the medial angle of the lids lack of pigmentation. The palperal fissure was oval in shape but broader toward the medial angle. The eyelids included Meibomian (tarsal glands) and ciliary glands. Goat's meibomian glands were found in the tarsal plate of both the upper and lower eyelids; the tarsal glands in the upper eyelid were more numerous and more developed than those in the lower lid. **Yasui; Tsukise; Nara; Kuwahara and Meyer (8)** in porcine added that, the ciliary glands, also known as glands of Moll.

Broadwater; Schorling; Herring and Pickett (9) observed that, pygmy goats (Capra hicus, which are native to Africa) had more movable upper eyelids than lower ones, and there were 40–60 cilia placed in two rows along the upper lids. When the eyelids were open, the upper cilia in the pygmy goats were always directed downward. Along the lower eyelids, cilia were arranged in single row of 20–30 shorter cilia, oriented away from the ground. When the goats blinked, the upper and lower palpebral cilia interdigitated. Twenty to thirty glandular openings were found at the junction of the palpebral margin with the palpebral conjunctiva along the upper and lower lids.

Regarding to goat third eye lid, **Diesem (7)** revealed that, the third eye lid consisted of the conjunctival covering of the cartilage and the glandular tissue, that was surrounding the base of the third eyelid. The cartilage within the membrane was T-shaped. The wider portion of the "T" being near the free margin of the third eyelid. The conjunctiva on the palpebral side of the cartilage reflected onto the caruncle at the medial angle of the eye. The fornix formed by the conjunctiva on the palpebral surface of the lid was not extensive. The conjunctiva lined the third eyelid eventually joined the palpebral conjunctiva of the upper and lower lids. The goat conjunctiva may contain small lymph nodules.

In ox, **Diesem (7)** recorded that, when examined the living animal, the eyelids were quite thick and appeared rolled or thrown into transverse hillocks. The cilia on the lower lid were present but they were shorter and less coarse than those on the upper lid. Although, the tarsal glands were imbedded in the tissue of the lids, their ducts were clearly visible. The upper lid might include 35 of these glands, while the lower lid might contain 25 of these glands. Eye lid muscles included the Orbicularis oculi muscle, Levator palpebrae superioris, Corregator supercilli (in the upper eye lid) and frontalis (in the lower eye lid) responsible for movement of the lids. **Ahmed (10)** in ox added that, the upper and lower eyelids consisted of anterior and posterior surface. Short hairs were present on the anterior aspect of the eyelids and skin in this place was thin and sensitive.

In many mammals, the superficial gland of the third eyelid and the harderian gland were located in the inner canthus. Although, the lacrimal gland was positioned in the outer canthus of the orbit. The superficial gland of third eyelid was found as a group of glandular tissue within it. Furthermore, the lacrimal gland considered as a portion of the lacrimal apparatus which responsible for the production of the aqueous layer of the tear film **(Payne, 11]** in domestic animals and **Sahadkhast; Bigham; Vhadkhast; Vajdi and Shafiei, (12** in goat**)**.

Kleckowska-Nawrot; Nowaczyk; Gozdziewska-Harlajczuk; Szara and Olbrych (13) in European bison stated that**,** there were harderian gland and superficial gland of the third eyelid, the harderian gland formed from multilobular tubuloalveolar organization with mixed secretion. The superficial gland of the third eyelid had a multilobar tubuloacinar configuration with a mucoserous secretion. The secretory cells of the harderian gland and superficial gland of the third eyelid had similar ultrastructural form, with two types of secretory vesicles in the cytoplasm of these glands. The harderian gland was also known as the deep gland of the third eyelid.

Abuagla; Ali and Ibrahim (14) in camel declared that, the two upper and lower eye lids guarded the eye. The preriorbita formed a two-layered fascial pocket surround the lacrimal gland. One layer of fascia was dorsal to the lacrimal gland. The obliqueus dorsalis and a layer of fat were also found in this pocket passing under rectus dorsalis muscle and lacrimal gland.

Liebich and König (15) reported that, in horse**,** there were three eyelids: the third eyelid, lower lid and the upper lid. The variation of size between the upper and lower lids controlled by the palpebral muscles. At the temporal and nasal angle of the eye, the free margins of the upper and lower lids were met. The nasal aspect of the eye found the lacrimal caruncle which considered a mucosal protrusion. The lacrimal puncta, through which the tear film drained, opened onto the lid margins close to the nasal angle. The upper and lower eyelids formed from three layers: skin, a middle musculofibrous layer and the mucous membrane. They were covered with hairs and containing glandular structures. Long hairs arose from the upper lid margins. The eyelids contained several glands; sebaceous glands, ciliary glands and tarsal glands. The sebaceous glands opened into the follicles of the cilia, ciliary glands were coiled, tubular, apocrine sweat glands that secreted into hair follicles and the tarsal glands which act as modified sebaceous glands. The previously mentioned glands secreted the oily superficial layer of the tear film.

Liebich and König (15) added that, the third eyelid or semilunar fold of the conjunctiva placed dorsoventrally and extended from the nasal canthus between the lacrimal caruncle and the eyeball. It was maintained by a T-shaped piece of cartilage, which formed from elastic cartilage in the horse, pig and cat. While, in dog and ruminants its type was hyaline. Numerous lymphatic nodules were found within the third eyelid. The base of the cartilage was surrounded by the superficial gland of the third eyelid.

Steven and Gebert (16) found that, in most domestic animals the dermal part of the palpebral conjunctiva contained organized lymphoid follicles. The latter termed conjunctiva-associated lymphoid tissue (CALT).

Samuelson (17) in horse declared that, the periorbital fascia was a conical fibrous membrane, that lined the bony orbit and bounded the eyeball with its muscles, blood vessels, and nerves. The apex of periorbita placed at the exit of the optic nerve from the eyeball. Also, it was a thin membrane, attached firmly to the orbital bones, and their periosteum**.** The fascial sheaths of the extraocular muscles were dense fibrous membranes slightly attached to the muscles with fine trabeculae of connective tissue in horse.

The previous author in horse documented that, tenon's capsule which considered a sheath surrounding the eyeball and fascia of the bulb of eye. It formed from a condensation of connective tissue on the outer part of the sclera, from which it was separated by a narrow, cleft like space filled with loose connective tissue, that was Tenon's space.

Concerning to orbital fascia, **Constantinescu and McClure (18)** in dog reported that, the muscular fasciae could be divided into three layers: a superficial, middle layer and deep layer. The superficial layer was thick and extended caudally from the orbital septum and was perforated by blood vessels and nerves. A middle layer, which consisted of superficial and deep sheets that attached rostrally to the outer junction of the sclera and cornea. The third deep layer next to the surface of the extraocular muscles that separated the recti muscles from the retractor oculi muscles.

Regarding to orbital fat, **Sires; Saari; Garwin; Hurst; and Van Kuijk (19)** in domestic animals mentioned that, the orbital fat which filled the empty space in the orbit and served as a protective cushion for the eye and surrounding muscles. It located between the three sheets of orbital fascia. The amount of orbital fat changed from one animal to another. The orbital fat ranged in color from white to yellow. Significant amounts of lutein, beta carotene, and retinol, as well as a lesser amount of unidentified carotenoids were shown to be responsible for the existence of yellow color.

Dyce et al. (20) in domestic animals asserted that, the ocular muscles were movable and situated behind the eyeball. There were four rectus muscles, two oblique muscles and retractor muscle. All muscles had their origin at the optic foramen at the tip of the orbital cone except ventral oblique muscle. The dorsal, ventral, medial, and lateral rectus muscles were attached anterior to the equator by broad and delicate tendons. The dorsal and ventral oblique muscles were connected to the eyeball close to the equator, and when they contracted they rotated the eyeball around the visual axis.

A fore mentioned authors in domestic animals documented that, the dorsal oblique muscle also originated near to the optic foramen and passed forward on the dorsomedial wall of the orbit before it was reflected around the trochlea to end on the dorsolateral surface of the eyeball beneath the tendon of the dorsal rectus muscle. If this muscle contracted alone, it would pull the dorsal part of the eyeball medially. The ventral oblique muscle, uniquely did not arise from the vicinity of the optic foramen instead it took its origin from a depression in the ventromedial wall of the orbit passing laterally below the eyeball and the tendon of the ventral rectus muscle before inserting on the ventrolateral part of the eyeball. Its contraction if isolated from the action of the other muscles would rotate the eyeball around the visual axis so that the dorsal portion of the eyeball would move laterally**.**

Samuelson (17) in domestic animals reported that, the retractor oculi (bulbi) muscle originated at the orbital apex. It continued forward to envelop the optic nerve in a cone-shaped structure before inserting deeply behind the recti muscles. The globe was retracted into the orbit by this muscle bundle. Although the retractor oculi muscle found in all mammals, it not found in a number of non-mammal species, such as birds and snakes.

Concerning to lacrimal apparatus (apparatus lacrimalis), in goat, **Raja; Ushakumary; Kannan; Rajathi and Ramesh (21)** asserted that, the lacrimal gland was positioned mostly under the frontal bone and it covered the rectus dorsalis muscle. The lacrimal gland was oval in shape, flattened and light brown in color. The gland had two unique features: a body and an extension of the body that resembled an appendage. The lacrimal gland and the inner surface of the supraorbital process of the frontal bone were surrounded by the periorbital tissue.

Alsafy (22) stated that**,** the nasolacrimal duct elongated from the lacrimal sac to the nostril in the wall of the nasal cavity, the upper part of the lacrimal duct passed within the bony lacrimal canal. The nasolacrimal duct ran in the osseus lacrimal canal rostrally, with a slight curve at its origin. It passed the lacrimal, zygomatic and maxillary bones. It passed through the maxillary sinus, and then traversed the nasal cavity in a curved descending manner. The nasolacrimal duct opened at the medial wall of the nasal vestibule at the junction between the mucous membrane and skin by the nasal opening. The nasolacrimal duct had a very minute opening measured about 0.1cm in camel, goat, and about 0.3cm in donkey. Its opening located away from the nostril by about 5cm in camel, 2cm in goat, and4cm in donkey.

Concerning to the eyeball, **Rajathi (21)** in goat described that, the eyeball was nearly spherical in shape. The pupil was present in horizontal plane and had an oval shape. The nasotemporal axis of the eyeball was slightly larger than the dorsoventral axis.

In most domestic animals, the eyeball had three thin tunics that being in close apposition, formed a laminated sheet that surrounded the partly liquid, partly gelatinous center. The three tuncis were (1) an external fibrous tunic, that protected the eyeball, it was the only complete tunic, consisted of cornea and sclera, (2) the middle vascular tunic, that consisted largely of blood vessels and smooth muscle and was concerned with the nutrition of the eyeball and the regulation of the shape of the lens and size of the pupil, consisted of choroids, ciliary body and iris, (3) the internal nervous tunic, that consisted largely of nervous tunic. The latter was the layer most directly concerned with vision **(20).**

Konsowa and Abdelaziz (23) stated that, the cornea of ox, buffalo, goat, camel and donkey macroscopically varied in its horizontal and vertical diameters. The vertical meridional diameter was smaller than the horizontal one in all animals except in buffalo, where they were nearly the same. So, the cornea appeared to be horizontally elliptical in the domestic animals under investigation except in buffalo, where it was nearly circular or rounded to oval. The cornea of goat had an egg shape with a narrow elongated lateral circumference and wide blunt medial one. In camel, the cornea was found to be elongated horizontally with a wide and rounded medial circumference than the lateral one. The dorsolateral border had a clear concavity giving it a bean-shaped appearance. The cornea of donkey was oval in outline with a broader medial circumference than the lateral one, giving a horizontally elongated ellipse.

Mazher (24) in goat observed that, cornea consisted from five layers microscopically arranged from outside to inside as the corneal epithelium, Bowman's membrane, substantia propria, Descemet's membrane and the corneal endothelium. The corneal epithelium was formed from stratified squamous non cornified epithelium which consisted of 10-14 layers of epithelial cells. Scanning electron microscopical examination revealed polyhedral to hexagonal surface epithelial squamous cells delineated from each other by thick tight junction.

Barhaiya; Malsawmkima; Vyas and Bhayani (25) found that, cornea of the adult Marwari goat (Capra hircus) considered the transparent anterior layer of the fibrous tunic. It was the greatest powerful refractory part of the eye. The goat cornea was one of the major densely innervated tissue in the body and supplied by sensory and autonomous nerve fibres. The shape of cornea was elliptical with a horizontal diameter greater than the vertical diameter. The cornea had greater curvature than the sclera, which provided the bulging appearance to the cornea. Cornea had a broader end at the medial side and a more pointed end at the lateral side.

Samuelson (17) suggested that, the sclera of domestic animals considered the remainder part of the fibrous tunic. Anteriorly, it connected with the peripheral cornea and the bulbar conjunctiva to form a transition zone (the limbus). At the limbus, the sclera was pigmented to different degrees, and the covering epithelium was thicker, with closely packed pigment cells.

Regarding to champers of the eye in domestic animals, the anterior chamber of the eye was enclosed anteriorly by the cornea and posteriorly by the iris and lens. It communicated through the pupil with the posterior chamber of the eye. It was a small annular space, triangular in cross-section, which was bounded anteriorly by the iris, posteriorly by the peripheral part of the lens and its ligaments, and externally by the ciliary processes. The anterior chamber and the posterior chamber of the eye were filled by the aqueous humor which considered a clear fluid. The vitreous chamber was located between the crystalline lens and the retina and contained the vitreous body **(15)**. Refractive media of the eye were the cornea, lens, aqueous humor and vitreous body in most domestic animals **(20).**

The lens was a transparent, biconvex structure suspended by the ciliary zonule. It had anterior and posterior poles, an equator and a central axis. The posterior surface was usually more convex than the anterior one. During accommodation, the convexity of the lens changed. In adult, the lens was avascular and its nutrition was delivered thorough diffusion from the aqueous and vitreous humor. The zonular fibres, which suspended the lens, inserted into the superficial layers of the lens capsule in domestic animals **(15).** In domestic animals, the lens was supported at the equator by the lens zonules or suspensory ligaments. The latter ligament attached to the processes of the ciliary body and suspended the lens in the middle of the pupil. Alterations of tension in these fibers altered the refractive optical power of the lens **(26)**.

The previous author in most domestic animals mentioned that, the vitreous body was a transparent elastic hydrogel. It occupied about 80% of the volume of the eye. The vitreous body formed from the following zones: 1- anterior vitreous, located anterior to the ora ciliaris retinae, 2- posterior vitreous, located posterior to the ora ciliaris retinae, 3- cortex, which comprised the peripheral vitreous, 4- central vitreous, including cloquet's canal. The latter was a cleft in the vitreous where the hyaloid vasculature passed during embryonic development. **Desmet; Gad Elkareem and Zwinderman (27)** in domestic animals documented that, the vitreous body was the largest structure within the eye. It was a highly hydrated transparent extracellular matrix containing 98-99% water. The distribution within the eye was not uniform, the highest concentration being present at the vitreous base followed by the posterior vitreous cortex, and the vitreous core. This network of collagen fibers provided the vitreous with mechanical strength, allowing it to sustain impacted, and transmitted tractional forces to the retinal surface.

Liebich and König (15) in horse observed that, aqueous humor which was produced by an active secretory process from the epithelium of the ciliary body. It was a clear and colourless fluid, containing several electrolytes, glucose, amino acids and ascorbic acid. It was important for the nutrition of the avascular structures of the eye (cornea and lens). The aqueous humor flown from its site of production into the posterior chamber, from here it passed through the pupil into the anterior chamber and drained through the spaces of the iridocorneal angle to the scleral venous plexus. In the healthy eye the rate of production balanced the rate of drainage, thus keeping intraocular pressure constant. Impairment of outflow resulted in an increase in intraocular pressure (glaucoma) leading to retinal atrophy and blindness.

Regarding to the internal layer of the eyeball (retina): **Soliman; Adam and Abd Allah (28)** in goat stated that, the retina extended rostrally to cover the ciliary body as pars ciliaris retinae and the iris as the pars iridis retinae. The retina appeared to be formed of ten layers, named from outward to inward as, retinal pigmented epithelium, rods and cones layer (photoreceptor cell layer), external limiting membrane, outer nuclear layer (cell bodies and nuclei of the photoreceptor cells), outer plexiform layer, inner nuclear layer (contained the horizontal, bipolar, Muller and a macrine cells), inner plexiform layer, ganglionic cell layer, nerve fiber cell layer (unmyelinated nerve fibers) and internal limiting membrane**.**

Rajathi (21) in goat mentioned that, retina was the innermost light sensitive layer of eye. The retina consisted of three layers of neuronal cells namely photoreceptor cells (rods and cones), bipolar cells and ganglion cells. Optic nerve was located ventral and lateral to the posterior pole. The retina was an off-white coloured delicate membrane which extended from the entrance of the optic nerve to the ciliary body, and it terminated at a circular line, the ora ciliaris retinae. Tapetum in both young and adult goat was located dorsal to the optic disc, mostly on the dorsal side and it was horizontal triangular in shape. It occupied the dorsal half of the retinal fundus and contained optic disc in its ventral part. Tapetum in goat was iridescent blue in colour in fresh but changed to metallic blue in colour on fixation. The optic disc in young and adult goat it was located at the junction of tapetum and nontapetum. The shape of the optic nerve head was round in goat in both young and adult animals. The whole retina was very loosely attached with choroid except at the optic papilla**.**

Concerning to blood supply of the eye, **Ghoshal (29)** in small ruminant stated that, the external carotid artery was the continuation of common carotid artery beyond the origin of the occipital artery. The maxillary artery was the continuation of external carotid beyond the origin of the superficial temporal or the common trunk for latter and the transverse facial artery. It originated ventrally in region of the retromandibular fossa and in the pterygopalatine fossa. The external ophthalmic artery was the continuation of maxillary artery. It pierced the periorbita and formed the ophthalmic rete mirabile, close to the origin of the extrinsic muscles of the eyeball. A few branches passed through the foramen orbitorotundum and anastomose with the internal ophthalmic artery. The supraorbital artery, after arising from the ophthalmic rete mirabile, passed through the supraorbital canal without emerging through the frontal opening of the canal.

The previous author added that, the external ethmoidal artery originated from the supraorbital artery and entered the cranial cavity via the ethmoid foramen. It formed an arterial plexus with the internal ophthalmic artery in the ethmoidal fossa of the ethmoid bone. The lacrimal artery arose from the external ophthalmic artery and, after coursing along the rectus dorsalis, reached the lacrimal gland in the goat. The muscular branches arose from the ophthalmic rete mirabile, course along the optic nerve, and near the eyeball divided into the anterior ciliary and long posterior ciliary arteries. The malar artery arose from the maxillary artery by a common trunk with the infraorbital artery and ran in a groove of the lacrimal bulla. It reached the medial angle of the eye and variably gave off the artery to the third eyelid, medial superior and inferior palpebral arteries.

Suzuki and Okuda (30) showed that**,** the malar artery of the goat gave off the medial superior and inferior palpebral arteries or a common trunk between them. The medial inferior palpebral artery formed the inferior palpebral arterial arch by anastomosing with the lateral inferior palpebral artery of the superficial temporal artery at the lateral canthus.

Miller (31) in most domestic animals documented that, the choroid received its main arterial supply from the following vessels: short posterior ciliary arteries which penetrated the sclera around the optic nerve, long posterior ciliary arteries which entered near the optic nerve and branch near the ora ciliaris retinae and lead back into the choroid, anterior ciliary arteries which send branches back into the choroid after penetrating the anterior sclera.

Dyce et al. (20) in domestic animals reported that, the nerve supply to the eye and its accessory structures was derived from no fewer than six cranial nerves. Most of these enter the orbital cone, but some reached accessory structures directly. The optic nerve entered the orbit through the optic foramen and passed to the light receptor cells in the retina. It entered the orbit through the orbital foramen (orbital fissure in horse; foramen orbitorotundum in ruminants and pig and sent branches to the levator palpebrae, the dorsal, medial, and ventral recti, the ventral oblique, and part of the retractor muscles. The trochlear nerve accompanied the occulomotor nerve and innervated the dorsal oblique muscle. The ophthalmic and maxillary divisions of the trigeminal nerve sent branches to the eye. The ophthalmic nerve passed through the orbital foramen and supplied the following sensory branches: long ciliary nerves to the eyeball especially the cornea, a lacrimal nerve to the eyelids and conjunctiva of the lateral angle, a supraorbital nerve to supply the upper eyelid and skin medial to the orbit, an infratrochlear nerve sensory to structures near the medial angle of the eye**.**

Computed tomography(CT):

Penninck; Daniel; Brawer and Tidwell (32) in small ruminant animals documented that, computed tomography (CT was useful, complementary cross-sectional imaging modalities of the eye and orbit. CT provided valuable morphologic and topographic images of both ocular and periocular structures, thereby giving a more complete picture of the pathological process. CT required general anesthesia. Fine-needle aspirations and biopsies under CT guidance could also be performed.

Madkour; Amin; Karkoura; Alsafy and El-Gendy (33) in goat mentioned that**,** the orbital bony rim completely encircled the globe and projected above the surrounding bony surfaces. The orbital cavity reduced in its size ventrorostrally by the presence of the lacrimal bullae, which was the orbital diverticulum of the maxillary sinus inside the orbital cavity. The CT images and anatomical sections determined the most structures of the eye orbit as; eye lens, vitreous body of eye, anterior chamber, muscles of eye and periorbital fat. The lacrimal gland was clear and located on the dorsolateral surface of the orbit. The orbital cavity not closed by bone but limited by the coronoid process of the mandible and temporomandibular joint. There was one supraorbital foramen and one wide infraorbital foramen. There were two lacrimal notches on the rostrodorsal border of the orbital cavity. The frontal sinus had an orbital diverticulum that extended dorsally and ventrally around the orbital cavity. The maxillary sinus had two diverticulums inside the orbital cavity named the tympanic bulla.

Beck; Rosenbaum and Miller (34) in human revealed that, orbital CT should include both transverse axial and coronal sections: the pathological condition and its plane of growth would influence the selection of the optimal plane or section. Coronal sections might be obtained either directly or indirectly by computer reconstruction from contiguous transverse images. Sagittal or oblique sections or both also were useful and might be obtained directly or indirectly. Difficulty in patient positioning might precluded direct sagittal imaging. However, the use of intravenous contrast enhancement was not necessary as a routine technique unless a mass was identified or suspected. It should be continually emphasized that CT was a powerful technology which, in orbital diagnosis, produced the highest yield when clinician. The clinical information supplied by the referring ophthalmologist was used by the radiologist both in the selection of the appropriate techniques for investigation and in striving to achieve the most specific conclusion.

Naik; Tourani; Sekhar and Honavar (35) in human recorded that, the use of thin sections with multiplanar scanning (axial, coronal and sagittal planes) and the possibility of three-dimensional reconstruction permited thorough evaluation, to make the most of this technique, users must familiarize themselves with the pertinent CT principles and terminology. The diagnostic yield was optimal when the ophthalmologist and radiologist collaborate in the radiodiagnostic workup. The sclera, choroid and retina together form a well-defined ring that enhanced with contrast. They cannot be differentiated from each other. The lens appeared white, and the vitreous black. The extraocular muscles were well visualised on CT, and run parallel to the adjacent orbital wall. On axial cuts, only the horizontal recti were seen. The superior and inferior recti, partially seen on axial scans, are visualised on coronal views. The superior rectus and the levator palpebrae superioris were seen as a single soft tissue shadow on high axial scans and coronal scans. The superior oblique was best seen in the coronal view lying superomedial to the superior rectus, but can also be seen on upper axial scans as it passed through the trochlea. The inferior oblique was the least defined muscle on CT scan, only the insertion was occasionally visible on axial views. The extraocular muscles and the fibrous tissue septa connecting them form the muscle cone and divide the orbit into intraconal and extraconal spaces, a division of radiodiagnostic importance.

Kažoka and Pilmane (36) in human confirmed that, a lot of digital images can be instructional tools for teaching Human Anatomy, but we recommend anatomy tutors to mix different teaching methods; new and traditional in order to create the desired transfer of knowledge. Students need to learn not just anatomical structures and functions, but also, the relationships between surrounding structures. Our students directly benefited from the digital images during their practical classes. Finally, we suggested that the students and the tutors should use digital images and the animations. The users could upload their own CT or MRI data of each system. The ability to upload and view any radiology image set (CT, MRI) expanded the veriety of the Anatomage Table both inside and outside practical classes.

Angiography of the eye:

LoPinto; Pirie; Ayres And Bedenice (37) stated that, Bergmeister's papilla were observed by direct ophthalmoscopy. The optic discs in sheep were frequently located in the junction between the tapetal and nontapetal regions, although sometimes totally included in the nontapetal fundus, just below the junction. They had elliptical or kidney-like morphologies, with the horizontal axes longer than the vertical axes. The sheep's retinal vascular patterns were more homogeneous than those of the goats. Sheep have three or four pairs of vessels arteries and veins, dorsal, ventral, ventronasal and ventrotemporal and additional five to eight arterioles and venules radiating from the temporal and medial portions of the optic disc. Pairing of larger dorsal and ventral vessels occurred more frequently than with the smaller vessels. Ventronasal, ventral, and ventrotemporal vessels were not always paired, with the ventral vein or ventronasal arteries as the vessels that were more often apart.

Galán; Martín-Suárez; Granados; Gallardo and Molleda (38) in sheep and goat stated that, the tapetal color was yellow, green, or blue, and limited reflection by the tapetal fundus was present in both species. In sheep, a common combination was a predominantly yellow or green tapetal fundus and blue at the junction with the nontapetal fundus. The reflection was maximum only in the yellow areas near to the stars of Winslow. The stars of Winslow were variable showing different color, size, and morphology. They were brown or reddish with a round or linear shape, probably due to the different position of the choroid's capillaries through the tapetal fundus. The goat optic-disc shape might be round or oval, and the homogeneous color of the papilla varied from pinkish to gray.

Conclusion

This review declared the anatomy of the eye and its adnexa in the different domestic animals with macroscopic and microscopic anatomy, Computed tomography (CT) and angiography to mention the various component of the eye especially bony orbit, ocular muscles and the three tunics of the eye.

References:

1. Chu, S.K.W.; Zhang, Y.; Chen, K.; Chan, C.K.; Wing, C.; Lee, C.W. Y.; Zou, E. and Lau, W. (2017): The effectiveness of wikis for project-based learning in different disciplines in higher education. internet and higher education, Vol. 33, :49–60.
2. Green, R.A.; Whitburn L.Y.; Zacharias, A.; Byrne, G. and Hughes, D.L. (2018): The relationship between student engagement with online con-tent and achievement in a blended learning anatomy course. Anat Sci Educ, Vol. 11, No.(5), :7-471.
3. Thom, M. L.; Kimble, B. A.; Qua, K. and Wish-Baratz, S. (2021): Is remote near-peer anatomy teaching an effective teaching strategy? Lessons learned from the transition to online learning during the Covid-19 pandemic. Anatomical sciences education, Vol. 14, No.(5), :552-561.
4. Sadeghinezhad, J. (2023): Online veterinary anatomy education during Covid-19 pandemic in Iran: Challenges and opportunities. Veterinary Medicine and Science, Vol. 9, Issue (4), :1869-1880.
5. Fails, A. D. and Magee, C. (2018): Sense organ, Chapter 12, Pp:229-251. In Fails, A. D. and Magee, C. (2018): Anatomy and Physiology of Farm Animals, 8th Edition. Wiley.
6. Choudhary, O. P.; Kalita, P. C.; Doley, P. J.; Kalita, A., and Arya, R. S. (2018): Morphometrical studies on the orbit of goat (Capra hircus) of Mizoram. Ruminant Sci, Vol. 7, No.(1), :71-72.
7. Diesem, C (1975): Organ of Vision, Chapter 25, Pp:703-719 and Chapter 36, Pp:1180-1203.
8. Yasui, T.; Tsukise, A.; Nara, T.; Kuwahara, Y. and Meyer, W. (2006): Morphological, histochemical and immunohistochemical characterization of secretory productions of the ciliary gland of the porcine eyelid. European Journal Histochem, Vol. 50, No.(2), :99-108.
9. Broadwater, J. J.; Schorling, J. J.; Herring, I. P. and Pickett, J. P. (2007): Ophthalmic examination findings in adult pygmy goats (Capra hircus). Veterinary Ophthalmology, Vol. 10, No.(5), :269-273.
10. Ahmed, N. S. (2012): Histological and histochemical study of eyelid of native cattle. Bas. J. Vet. Res., Vol. 11, :120-134.
11. Payne, A. P. (1994): The Harderian gland: A tercentennial review. Journal of Anatomy, Vol. 185, No.(1), :1-49.

12. Sahadkhast, M.; Bigham, S.; Vhadkhast, N.; Vajdi, N. and Shafiei, Z. (2008): Lacrimal apparatus system in goat (Capra aegagrus hircus): Anatomical and radiological study. Asian Journal of Animal Veterinary Advance, Vol. 3, No.(6), : 457-460.

13. Kleckowska-Nawrot, J.; Nowaczyk, R.; Gozdziewska-Harlajczuk, K.; Szara, T. and Olbrych, K. (2015): Histology, histochemistry and fine structure of the Harderian gland, lacrimal gland and superficial gland of the third eyelid of the European bison, Bison bonasus bonasus (Artiodactyla: Bovidae). Zoologia, Vol. 32, No.(5), :380-394.

14. Abuagla, I. A.; Ali, H. A. and Ibrahim, Z. H. (2016): An anatomical study on the eye of the one-humped camel (Camelus dromedarius). Inter J Vet Sci, Vol. 5, No.(3), :137-141.

15. Liebich, H. G. And König, H. E. (2004): Eye (organum visus), Chapter 16; 547-567. In König H. E. and Liebich H.G. (2004): Veterinary Anatomy of domestic animals, textbook, and colour atlas. 1st Edition. Stuttgart, Germany.

16. Steven, P. and Gebert, A. (2009): Conjunctiva-associated lymphoid tissue- Current knowledge, animal models and experimental prospects. Ophthalmic Research, Vol. 42, No.(1), :2-8.

17. Samuelson, A. D. (2013): Ophthalmic Anatomy, Section I, Chapter 2, Pp: 39-158.

18. Constantinescu, G. M. and McClure, R. C. (1990): Anatomy of the orbital fasciae and third eyelid in dogs. American Journal of Veterinary Research, Vol. 51, No.(2), :260–263.

19. Sires, B. S.; Saari, J. C.; Garwin, G. G. ; Hurst, J. S. and Van Kuijk, F. J. (2001): The color difference in orbital fat. Archives of ophthalmology, Vol. 119, No.(6), :868-871.

20. Dyce, K. M.; Sack, W. O. and Wensing, C. J. G. (2010): Textbook of veterinary anatomy, 4th Edition, The sense organs, Chapter 9, Pp:332-346. Elsevier Health Sciences.

21. Rajathi, S. (2021): Morphological and Morphometrical Studies of Eyeball and Retina in Goats. Indian Journal of Veterinary Anatomy, Vol. 33, No.(1), :17-19.

22. Alsafy, M. A. M. (2010): Comparative Morphological Studies on the Lacrimal Apparatus of One Humped Camel, Goat And Donkey. Journal of Applied Biological Sciences, Vol. 4, No.(1), :49-53.

23. Konsowa, M. and Abdelaziz, S. (1999): Comparative anatomy and histology of the cornea in some domestic animals. Zagazig University Medical Journal, Vol. v, No.(7), :478-495.

24. Mazher, K. M. (2012): Light and scanning electron microscopical studies of goat's cornea. Assiut Veterinary Medical Journal, Vol. 58, No.(135), :121-125.

25. Barhaiya, t. R. K.; Malsawmkima, D. M.; Bhayani and Vyas, Y. L. (2014): Histomorphological Study of Ciliary body, Iris and Irido-corneal angle in Adult Marwari Goat. International Journal Of Biomedical and Life Sciences, Vol. 5, No.(3), :412-418.

26. Ofri, R. (2008): Lens, Chapter 13, Pp: 258-276 and Vitreous, Chapter 14, Pp: 277-284.

27. Desmet, M. D.; Gad Elkareem, A. M. and Zwinderman, A. H. (2013): The Vitreous, the Retinal Interface in Ocular Health and Disease. Ophthalmologica Journal, Vol. 230, No.(4), :165-178.

28. Soliman, S. M.; Adam, Z. A. A. and Abd Allah, U. K. M. (2010): Light and electron microscopic structure of goat's retina. Journal of Veterinary Medical Research, Vol. 20, No.(1), :52-62.

29. Ghoshal, N. G. (1975): Heart and arteries, Chapter 33, Pp:960-1023. In Getty, R.; Sisson, S. and grossman, J. D. (1975): The anatomy of domectic animals, 5th Edition, W.B. Saunders, Philadelphia, London, Toronto.

30. Suzuki, Y. and Okuda, H. (1991): On the a. malaris of the goat (Capra hircus). Okajimas Folia Anat Jpn, Vol. 67, No.(6), :15-405.

31. Miller, P. E. (2008): Uvea, Chapter 11, Pp: 203-229,

32. Penninck, D.; Daniel, G. B.; Brawer, R. and Tidwell, A. S. (2001): Cross-sectional imaging techniques in veterinary ophthalmology. Clinical techniques in small animal practice, Vol. 16, No.(1), :22-39.

33. Madkour, N.; Amin, M.; Karkoura, A. A.; Alsafy, M. A. and El-Gendy, S. A. (2016): Computed Tomography and Gross Anatomical Studies of the Orbital Cavity of the Baladi Goat (Capra hircus). Alexandria Journal for Veterinary Sciences, Vol. 51, No.(2), :74-81.

34. Beck, T. J.; Rosenbaum, A. E. and Miller, N. R. (1982): Orbital computed tomography: technical aspects. International Ophthalmology Clinic. Winter, Vol. 22, No.(4), :7-39.

35. .Naik, M. N.; Tourani, K. L.; Sekhar, G. C. and Honavar, S. G. (2002): Interpretation of computed tomography imaging of the eye and orbit. A systematic approach. Indian Journal Ophthalmology, Vol. 50, No.(4), :339-953.

36. Kažoka, D. and Pilmane, M. (2017): Teaching and learning innovation in present and future of human anatomy course at RSU. Papers on Anthropology, Vol. 26, No.(2), :44-52.

37. LoPinto, A. J.; Pirie, C. G.; Ayres, S. L. And Bedenice, D. (2017): Comparison of indocyanine green and sodium fluorescein for anterior segment angiography of ophthalmically normal eyes of goats, sheep, and alpacas performed with a digital single-lens reflex camera adaptor. American journal of veterinary research, Vol. 78, No.(3), :311-320.

38. Galán, A.; Martín-Suárez, E. M.; Granados, M. M.; Gallardo, J. M.; and Molleda, J. M. (2006): Comparative fluorescein angiography of the normal sheep and goat ocular fundi. Veterinary ophthalmology, Vol. 9, No.(1), :7-15.